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Piezoelectric properties of diphenylalanine microtubes: comparison of cyclo- and linear structural forms

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Piezoelectric coefficients of cyclo-diphenylalanine microtubes have been evaluated by piezoresponse force microscopy on non-polar and polar sides and were compared to those of linear-diphenylalanine microtubes. It has been shown that cyclo-diphenylalanine microtubes at larger size possess 10 times smaller piezoelectric coefficients.

Nowadays, development of nano- and micromechanical systems based on organic and biomaterials attracts significant attention of researchers in chemistry and physics. The most promising biomaterials are organic microtubes of dipeptide diphenylalanine (FF) possessing strong piezoelectric [1], pyroelectric [2] and ferroelectric [3] features and structural flexibility. Recently, the FF microtubes have been shown to have high Young modulus due to water inside the nanochannels [4]. However, such FF microtubes have small diameter up to 50 micron and high aspect ratio simultaneously, so that they are not useful for some possible mechanical applications and, moreover, investigation of polar side becomes too complicated.

In the present work, the piezoelectric properties of cyclo-FF (CFF) microtubes were investigated using piezoresponse force microscopy. CFF microtubes were grown from water-alcohol solution with increased concentration of monomers. They have diameter up to 700 micron and length up to 5 mm. CFF microtubes were fixed horizontally on conductive substrate by silver paste for better electrical contact to study non-polar side as it was done for linear form of FF microtubes earlier [1]. In order to study piezoelectric properties on polar side CFF microtubes were sliced and fixed vertically on conductive substrate by silver paste as well. Local vibrations of the surface under applyed external voltage were registered and local piezoelectric coefficient $d_{15(local)}$ = 7.7 pm/V and $d_{33(local)}$ = 0.7 pm/V were evaluated. In contrast to microtubes of linear form of FF these piezocoefficients are about 10 times smaller.

Thus, it was shown that cyclo-FF microtubes have extremely big dimensions but 10 times smaller piezoelectric coefficients than that of linear-FF microtubes.

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